COMMENT

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The US government's helium reserve near Amarillo, Texas, meets around one-third of world demand for the gas.

Stop squandering helium

Establish a global agency to build a sustainable market for this precious commodity, say **William J. Nuttall**, **Richard H. Clarke** and **Bartek A. Glowacki**.

In recent months, researchers have struggled to obtain supplies of liquid helium for running and cooling their equipment. A UK newspaper reported in March how the shortage had led one scientist to waste £90,000 (US$142,000) because he could not run experiments on his neutron beamline for three days[1]. The scientist criticized buyers of party balloons for frittering away the gas. But the blame does not lie there.

Helium is an extraordinary commodity. Its use in advanced technologies — from cryogenics and arc welding to space rockets and silicon-wafer manufacture — means that worldwide demand for this inert gas is growing rapidly. But we are not conserving this resource well. Natural gas remains the richest and most accessible source of helium; extracting it in industrial quantities from the air would be extremely costly. But too often, natural-gas plants treat helium as a valueless gas and vent it to the atmosphere. One large-scale plant producing liquefied natural gas can waste more helium than all the party balloons in the world.

The helium that is extracted is in the hands of a few players. This, combined with the fact that there is little spare capacity, leads to intermittent supply shortages. The US government's decisions to stockpile helium in the 1960s and sell it off in the 1990s have constrained prices artificially. Economic incentives for the natural-gas industry to invest in the separation of helium have been insufficient, and although advances in fossil-fuel production methods should be making helium separation easier, this opportunity is not being seized.

As demand for helium grows in Asia and new separation plants come online in other countries, the US domination of the helium market will wane. An international body is now needed to oversee global plans for helium. We must extract and geologically stockpile the helium from gas reserves now, and postpone the use of air-extraction methods for as long as possible.

Helium was first liquefied by Dutch physicist Heike Kamerlingh Onnes in 1908, aiding his 1911 discovery of superconductivity in mercury cooled by helium to very ▶

low temperatures. (Superconducting magnets remain a major component of today's demand.) In 1906, US chemists Hamilton Cady and David McFarland had discovered that helium was associated geologically with natural gas[2], and along with chemical engineer Clifford Seibel, they handed expertise and leadership in helium production to the United States (see 'Supply and demand').

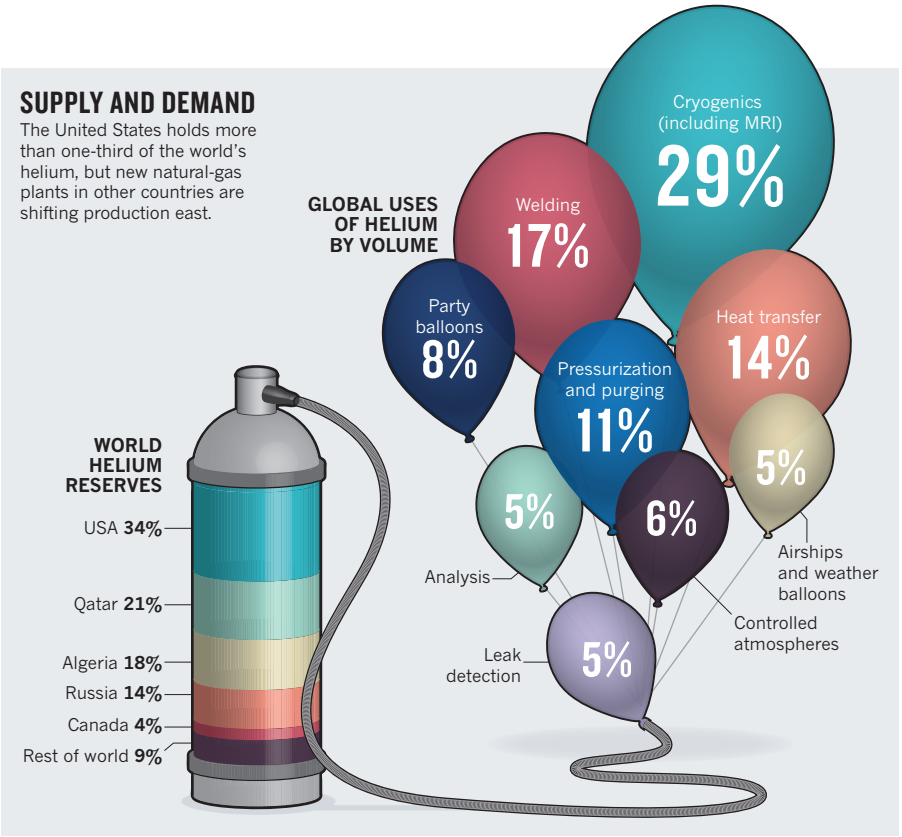
A NOBLE STRATEGY

Realizing helium's potential as a lifting gas, the US government was the first to extract and store it for strategic purposes — such as airships, rocket-fuel propellant and electronics manufacture. A vast helium store was instigated at the Bush Dome reservoir in the Cliffside gas field near Amarillo, Texas. After passing the US Helium Act Amendments of 1960, the government purchased large amounts of the gas from private companies and stored it. By the early 1970s, the helium stockpile amounted to more than 20,000 tonnes (see 'Helium sales on the rise'). This remained one of the few sources of commercial helium until 1977, when plants opened in Odolanow, Poland, and Orenburg, Russia.

By the 1990s, however, both the stockpile and the associated federal debt were seen as excessive. In the Helium Privatization Act of 1996, the US Congress resolved to retain a small, strategic reserve of around 2,800 tonnes; since 1998, more than half of the remainder has been sold off by the US Bureau of Land Management. Today, roughly one-third of global helium demand is met by the Amarillo reserve.

Market modelling suggests that, by 2030, demand for helium in technological uses may double[3]. Yet there is sufficient helium in the ground to meet our long-term needs. Global geological reserves are estimated at approximately 8 million tonnes. Released by radioactive minerals at a rate of thousands of tonnes each year, helium is trapped by rock in natural-gas fields at levels ranging from a few parts per million to as much as 7% by volume. Annual production runs at approximately 30,000 tonnes; in 2011, 77% of all helium came from the United States (down from 84% in 2004)[4].

Yet the natural-gas industry pays scant attention to helium. The global wholesale helium market turns over roughly $1 billion annually, a tiny sum in comparison with the $1 trillion generated by natural gas every year. All too frequently, helium remains blended throughout the gas supply chain until it is vented when natural gas is burnt. Unlike fossil fuels, where unused supplies remain in the ground for later use, any helium that is not separated is lost.



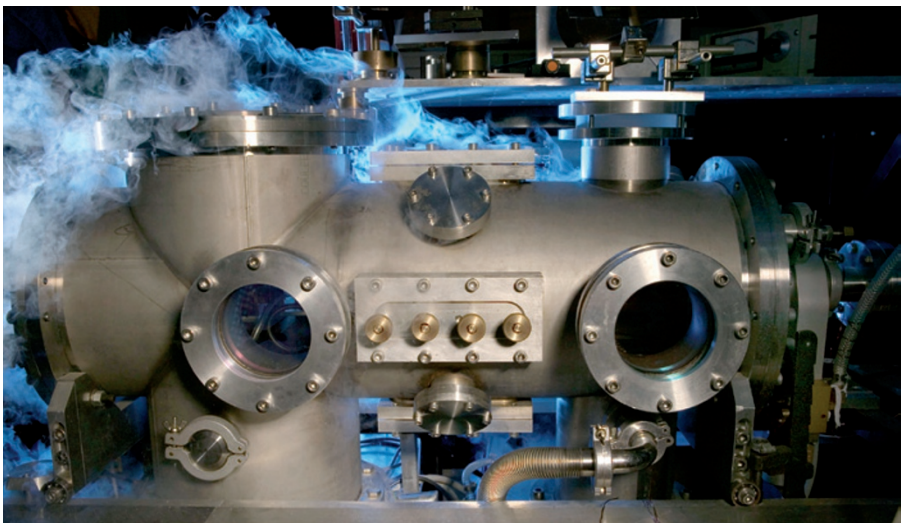
RISING PRICES

Helium prices are a function of supply and demand. In addition to the US government, the market is dominated by six companies: Paris-based Air Liquide, Air Products in Pennsylvania, Linde Group and Messer (both in Germany), Matheson in New Jersey and Connecticut-based Praxair. Although this number is sufficient for global competition, some firms effectively have a monopoly in certain regions. US government intervention creates uncertainty for all these companies, who also have to respond to rapid changes and trends in natural-gas extraction.

There is also a wide variety of helium consumers with their own perceptions of need and of how much they are willing to pay. For some, such as operators of magnetic resonance imaging (MRI) equipment for medical diagnosis, helium is an essential business requirement. For others, it is merely a discretionary spend.

These factors combine to create market anxiety. A sense of crisis can descend quickly when upstream supply problems occur — as happened in 2004 after an accidental explosion at a helium-producing facility in Skikda, Algeria, which killed 27 people. Algeria has only recently finished rebuilding the Skikda facilities, and is just about to return to the helium business.

All these reasons have led to an increase in average helium prices. They would



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Helium is used in cryogenic systems, such as in the study of large-scale quantum effects.

be even higher in a normal competitive market, but under US law, the Bureau of Land Management increased helium prices by only as much as the (inappropriately low) consumer price index. Suppressed prices deter upstream investment.

As each crisis hits, helium users face a trilemma — to pay high prices, to shut down facilities temporarily or to find a substitute for helium. But managing demand will not fix the real tragedy of helium venting. In the longer term, helium production and storage need to be expanded and embedded within the natural-gas industry.

ENERGY TRENDS

Transformations that are under way in the natural-gas industry offer opportunities and challenges for the helium market. The increasing use of natural gas for electricity generation means that energy companies are investing billions of dollars in new facilities. This growth could be a boon for helium production, if separation technology were routinely fitted to new plants. Cryogenic processing of liquefied natural gas (at around 112 K) greatly improves the extraction of helium, even when source concentrations of helium are as low as 0.015%, but it is not always done. Because most other by-products condense at these cold temperatures, helium can comprise up to half the waste gas purged from a natural-gas plant[5].

Other trends in the industry hold less promise for helium production. Most shale gas — produced by hydraulic fracturing (or fracking) of impermeable rocks to extract trapped natural gas — contains almost no helium because its molecules are small enough to diffuse through shale rocks. Greater US production of shale gas means that the country can produce enough gas to exceed its national demand, which has shifted thoughts towards exporting liquefied natural gas rather than importing it[6]. If such export plants are built, extra helium can be recovered from helium-rich source gas.

Energy decisions that are being made now by the United States will affect the global helium market. The future of the federal helium reserve is currently being considered by Congress: the Helium Stewardship Act proposes the retention of the Amarillo reserve beyond 2015 (when the 1996 act expires) by decreasing sales and improving management of the reserve.

An influential 2010 report[7] by the US National Academy of Sciences concluded that the helium sell-off was not in the national interest: if it continued, the United States would have to import helium from the Middle East and Russia in 10–15 years. The committee recommended that researchers should be given priority access to helium reserves, as well as funds for technology upgrades to reduce their helium usage. But these are short-term measures that centre on the United States.

Helium is a global and long-term issue. Both its demand and its supply bases are shifting east. Although US helium use has long been static, use is growing significantly in countries such as China and South Korea, and production facilities are coming online in the Middle East. In 2013, the world's largest helium-refining unit will open in Qatar, capable of producing more than 20% of global helium[8]. The long-term role of the United States in the helium business is far from certain, but decline seems likely. US policy towards both helium and natural gas will be important in determining the pace of shifts in global markets.

GLOBAL REACH

The time has come for the world to establish an international oversight body for helium that will set up new strategic reserves and expand helium production by recovering the noble gas at all major sources.

An international helium agency, operating along similar lines to the International Energy Agency, could draw on multiple strategic stocks around the world to attenuate market shocks and their accompanying price rises. Should unforeseen crises arise, the agency could develop best practices for preserving supply, such as prioritizing customers or rationing. A global agency is urgently needed to address the long-term issues facing the supply and demand of this precious element. In particular, many helium-bearing gas fields have a low energy content, so incentives to develop these fields may be needed.

Helium extraction should become the norm for existing liquefied natural-gas plants and for all new ones, particularly where the source gas is rich in the element. We propose a competitive market for helium in a global economy, with supply largely in private hands. The role of the private sector enhances helium security through free trade and market efficiency in allocating resources. The US model that existed before privatization in 1996 — a combination of private companies and an administered strategic reserve — offers a useful template.

The near-term future of helium will be one of expanded demand coupled with ongoing uncertainty in supply. Whether this growth in demand will be sufficient to motivate investments in upstream supply is far from clear. For this reason, we recommend that global attention is devoted to these issues before we squander this exceptional element through neglect. ■

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SOURCE: US BUREAU LAND MGMT/S. J. MAIONE

HELIUM SALES ON THE RISE

Annual production and sales of helium from the US federal reserve in Amarillo, Texas. After building up the reserve in the 1960s, legislation in 1996 required the nation to sell off its helium stockpile.